Chapter 3
Plan Formulation

The plan formulation process for Federal water resources studies is identified in the P&G (WRC 1983) and consists of the following deliberate and iterative steps:

1. Specify the water and related land resources problems, needs, and opportunities to be addressed.

2. Identify existing and projected future resources conditions likely to occur in a study area.

3. Define problems, needs, and opportunities to be addressed, and develop planning objectives, constraints, and criteria as the basis for formulating potential management measures and potential alternative plans to meet planning objectives within planning constraints.

4. Evaluate the potential effects of alternative plans.

5. Compare alternative plans.

6. Select a plan for recommendation to decision makers based on the comparison of alternatives and rationale for implementation or no action.

The planning process is led by a multiple-agency planning team, and involves the input and participation of concerned stakeholders, advisory groups, regulatory agencies, and members of the general public. This Draft Feasibility Report documents the plan formulation process as the basis for decision making by the Secretary of the Interior and Congress. Cooperating agencies and entities, including the State, will participate in this decision making.

Progress and results of the Investigation have been documented in a series of interim reports that will culminate in a Feasibility Report and an EIS/EIR. The Feasibility Report is the final planning report in the feasibility study process and builds on the results and findings of the previous interim planning.

The complete plan formulation approach and feasibility study process for the Investigation is illustrated in Figure 3-1 and described below:

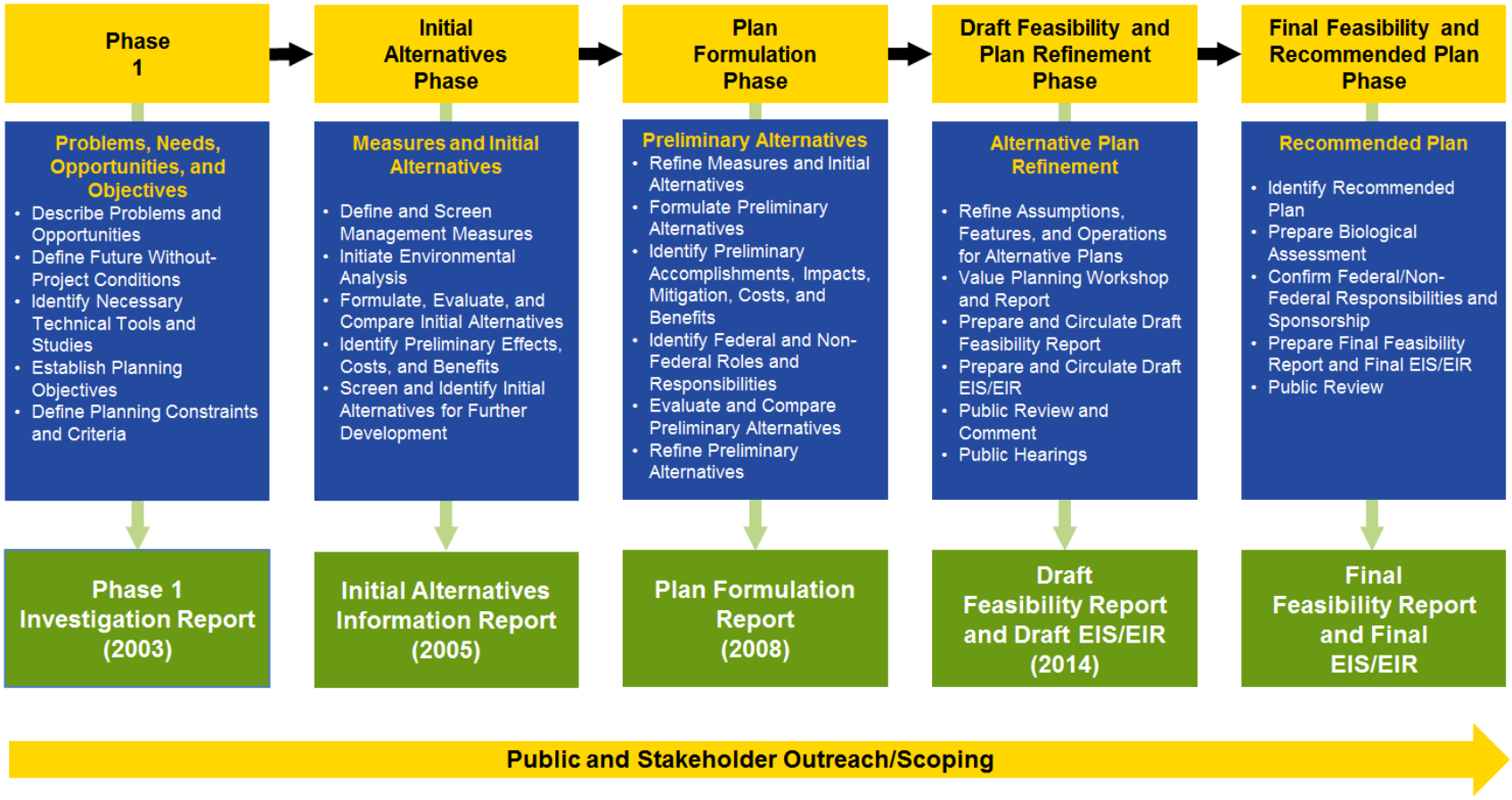

Figure 3-1. Plan Formulation Process

- **Phase 1** – This phase identified and addressed 17 possible reservoir sites in the eastern San Joaquin Valley and selected 6 for continued study. Formal initiation of environmental compliance processes also began in this phase.

- **Initial Alternatives Phase** – This phase evaluated 24 reservoir measures (based on location and size), many with multiple alternative hydropower generation options. In addition, several initial water operations scenarios addressing various planning objectives were identified and evaluated. Four reservoir sites were selected for continued study.

- **Plan Formulation Phase** – Plan formulation phase analyses refined initial alternatives to four groupings of Alternative Plans, based on two dam site locations and inclusion/exclusion of a new Trans Valley Canal. The four groupings of alternative plans were then evaluated based on P&G planning criteria, ability to address planning objectives, and meet planning constraints and considerations. The Temperance Flat RM 274 Reservoir grouping of alternative plans (without the Trans Valley Canal) was retained for further evaluation.

- **Draft Feasibility and Plan Refinement Phase** – This phase focuses on further physical features and operations refinement of the alternative plans to identify a plan suitable to be recommended for implementation. This phase includes preparing and circulating a Draft Feasibility Report and Draft EIS/EIR.

- **Final Feasibility and Recommended Plan Phase** – The next phase of the Investigation will focus on responding to comments, identifying a recommended plan, preparing a BA, and confirming Federal and non-Federal responsibilities. This phase will conclude with preparation of a Final Feasibility Report to support a Federal decision, and a Final EIS/EIR.

Reclamation, DWR, and cooperating agencies carried out public and stakeholder outreach activities throughout the plan formulation process, as shown in Figure 3-1.

Planning Objectives

This section discusses Federal and State planning objectives, and objectives, constraints, considerations, and criteria specific to the Investigation.

Federal and State Objectives

The Federal objective for water resources planning is defined in the P&G:

> *The Federal objective of water and related resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.*

Contributions to national economic development (NED) are further defined as "increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are direct net benefits that accrue in the planning area and the rest of the Nation" (WRC 1983).

The federal objective to be implemented through the *Principles and Requirements for Federal Investments in Water Resources* (P&R) (CEQ 2013) is:

> *The Federal objective, as set forth in the Water Resources Development Act of 2007 (Public Law 110-114, Section 2031), specifies that Federal water resources investments shall reflect national priorities, encourage economic development, and protect the environment by:*
>
> - *seeking to maximize sustainable economic development;*
>
> - *seeking to avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and*

- *protecting and restoring the functions of natural systems and mitigate unavoidable damage to natural systems.*

In consideration of the many complex water management challenges and competing demands for limited Federal resources, Federal agencies investing in water resources should strive to maximize public benefits, particularly compared to costs. Public benefits encompass environmental, economic, and social goals, including monetary and non-monetary benefits, and allow for the inclusion of quantified and unquantified benefits. Stakeholders and decision makers expect the formulation and evaluation of a diverse range of alternative solutions. Such solutions may produce varying degrees of benefits and/or impacts relative to the three goals specified above. As a result, trade-offs among potential solutions will need to be assessed and properly communicated during the decision-making process.

As a partner with the Federal government, DWR requires that economic analyses conducted for programs and projects be conducted fundamentally in accordance with the Federal planning principles defined in the P&G (WRC 1983); however, innovative methods and tools can also be incorporated when appropriate, such as California's SB 1.

The California Water Commission has new responsibilities under California's comprehensive water legislation, Senate Bill 1, regarding the distribution of State funds for the public benefits of water storage projects, and is developing regulations and guidelines to quantify and management of those benefits.

The CALFED ROD (2000a) provides a programmatic framework for participating Federal and State agencies to develop and implement a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system.

Planning Objectives

On the basis of the problems, needs, and opportunities identified and defined in Chapter 2, study authorities, and other pertinent direction, including information contained in the August 2000 CALFED ROD (2000a) and supporting documents, primary and secondary planning objectives were developed. Primary objectives are those for which specific alternatives are formulated to address. The primary planning objectives are considered to have coequal priority, with each pursued to the maximum practicable extent without adversely affecting the other. Secondary planning objectives are actions,

operations, or features that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary objectives.

- Primary Planning Objectives:
  - Increase water supply reliability and system operational flexibility for agricultural, M&I, and environmental purposes in the Friant Division, other San Joaquin Valley areas, and other regions.
  - Enhance water temperature and flow conditions in the San Joaquin River from Friant Dam to the Merced River in support of restoring and maintaining naturally reproducing and self-sustaining anadromous fish (i.e., spring-run and fall-run Chinook salmon [*Oncorhynchus tshawytscha*]) and other fish populations.
- Secondary Planning Objectives:
  - Reduce frequency and magnitude of flood releases from Friant Dam.
  - Maintain the value of hydropower attributes.
  - Maintain and increase recreational opportunities in the study area.
  - Improve San Joaquin River water quality downstream from Friant Dam.
  - Improve quality of water supplies delivered to urban areas.

Planning Constraints and Other Considerations

The P&G provides fundamental guidance for the formulation of Federal water resources projects (WRC 1983). In addition, basic planning constraints and other considerations specific to the Investigation must be developed and identified. Following is a summary of constraints and considerations being used for the Investigation.

Planning Constraints

Planning constraints help guide the feasibility study. Some planning constraints are more rigid than others. Examples of more rigid constraints include congressional direction in study authorizations; other current applicable laws, regulations, and

policies; and physical conditions (e.g., topography, hydrology). Other planning constraints may be less restrictive but are still influential in guiding the process. Examples include water resource planning efforts, such as the CALFED ROD. Several key constraints identified for the Investigation are as follows.

Study Authorizations

In 2003, Federal authorization was provided to prepare a Feasibility Report for storage in the upper San Joaquin River Basin (Public Law 108-7, Division D, Title II, Section 215). Additional authorization was given in the October 2004 Water Supply, Reliability, and Environmental Improvement Act (Public Law 108-361). Based on Section 227 of the CWC, State authorization is in place to study reservoirs or reservoir systems for gathering and distributing flood or other water not under beneficial use in any stream, stream system, lake, or other body of water.

CALFED Record of Decision

CALFED was established to "develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system." The 2000 CALFED ROD (CALFED 2000a) includes program goals, objectives, and projects primarily to benefit the Bay-Delta system. The objectives for the Investigation are consistent with the CALFED ROD (CALFED 2000a), as follows:

> *…250-700 TAF of additional storage in the upper San Joaquin River watershed. It would be designed to contribute to restoration of and improve water quality for the San Joaquin River and facilitate conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities. Additional storage could come from enlargement of Millerton Lake at Friant Dam or a functionally equivalent storage program in the region.*

The ROD has been adopted by various Federal and State agencies as a framework for further consideration. In addition to objectives for potential additional storage in the upper San Joaquin River Basin, the Preferred Program Alternative in the ROD includes four other potential surface water and various groundwater storage projects to help reduce the gap between water supplies and projected demands. Expanding water

storage capacity is critical to the successful implementation of all aspects of the program. Water supply reliability rests on capturing peak flows, especially during wet years. New storage must be strategically located to provide the needed flexibility in the current water system to improve water quality, support fish restoration goals, and meet the needs of a growing population. The CALFED ROD also includes numerous other projects to help improve the ecosystem functions of the Bay-Delta system. Alternative plans should address the goals, objectives and programs of the CALFED ROD (2000a).

Laws, Regulations, and Policies

Numerous laws, regulations, executive orders, and policies need to be considered, among them: the P&G, NEPA, Fish and Wildlife Coordination Act, Clean Air Act, CWA, National Historic Preservation Act, California Public Resources Code, ESA and CESA, CEQA, CVPIA, and the San Joaquin River Restoration Settlement Act. See Chapter 6 for more details.

Statewide Water Operation Planning Considerations

A set of assumptions for operations of the CVP and SWP for the No-Action Alternative and alternative plans was developed in 2012 assuming that current system facilities and operational constraints would not change for the without-project conditions. Federal planning guidance was used to make assumptions about which future projects and plans may or may not be implemented; and correspondingly, which should be included or excluded from these models and evaluations. The most up-to-date information and assumptions are used for the operations modeling at each phase of the Investigation.

Some key areas of uncertainty potentially affecting operational analyses for the Investigation include implementation of the SJRRP Restoration Goal and Water Management Goal on the operations of Friant Dam and the San Joaquin River, and changes in Delta export regulations or policies resulting from the BOs for the Coordinated Long-Term Operation of the CVP and SWP, new ESA and CESA listings, or recommendations from various planning processes for the Delta, including the Delta Vision, Delta Plan, and the BDCP.

Sacramento-San Joaquin Delta

Modeling studies will be updated to reflect changes in water operations resulting from ongoing CVP and SWP long-term operations consultation and other relevant water resources projects and programs, including, potentially, BDCP efforts. The results of these updated studies will be considered further in the Final Feasibility Report.

Other Planning Considerations

Planning considerations relate to economic justification, environmental compliance, technical standards, etc., and may result from local policies, practices, and conditions. Examples of these planning considerations, used in the Investigation for formulating, evaluating, and comparing initial plans, and later, detailed alternatives, include the following:

- A direct and significant geographical, operational, and/or physical dependency must exist between major components of alternatives.

- Alternatives should address, at a minimum, all of the identified primary planning objectives, and, to the greatest extent possible, the secondary planning objectives.

- Measures to address identified secondary planning objectives should be either directly or indirectly related to the primary planning objectives (i.e., plan features should not be independent increments).

- Alternatives should account for mitigation of affected hydropower generation value.

- Alternatives should consider issues raised in coordination with other Federal and State agencies.

- Alternatives should avoid any increases in flood damages or other substantial hydraulic effects to areas downstream on the San Joaquin River.

- Alternatives should either avoid potential adverse effects to environmental, cultural, and historical resources or include features to mitigate unavoidable effects.

- Alternatives should not result in a substantial adverse effect to existing and future water supplies, or related water resources conditions.

- Alternatives should either avoid potential adverse effects to recreational resources or include features to mitigate unavoidable effects.

- Alternatives should be formulated and evaluated based on a 100-year period of analysis.

- Construction costs for alternatives should reflect current prices and price levels, and annual costs should include the current Federal discount rate and an allowance for interest during construction (IDC).

- Alternatives should have a high certainty for achieving intended benefits and not depend on long-term actions (past the initial construction period) for success.

Criteria

The Federal planning process in the P&G also includes four specific criteria for consideration in formulating and evaluating alternatives: completeness, effectiveness, efficiency, and acceptability (WRC 1983).

- Completeness is a determination of whether a plan includes all elements necessary to realize planned effects, and the degree that intended benefits of the plan depend on the actions of others.

- Effectiveness is the extent to which an alternative alleviates problems and achieves objectives.

- Efficiency is the measure of how efficiently an alternative alleviates identified problems while realizing specified objectives consistent with protecting the Nation's environment.

- Acceptability is the workability and viability of a plan with respect to its potential acceptance by other Federal agencies, State and local governments, public interest groups, and individuals.

These criteria, and how they apply in helping to compare alternative plans, are described in Chapter 5.

Management Measures

Once water resources problems, needs, and opportunities have been identified, and planning objectives, constraints, considerations, and criteria have been developed, the next major plan formulation process element is identifying management measures. A management measure is any structural or nonstructural project action or feature that could address the planning objectives and satisfy the other applicable planning constraints, considerations, and criteria. Alternative

plans are formulated by combining retained management measures that address primary planning objectives, and adding measures that address secondary planning objectives.

Measures Considered

Numerous potential measures to address the planning objectives were identified based on information from previous studies, environmental scoping, and outreach to address the planning objectives and satisfy the applicable planning constraints, considerations, and criteria. Measures were reviewed and refined through Study Management Team (SMT) meetings, field inspections, and coordination with stakeholders.

Measures addressing primary planning objectives were grouped into broad categories associated with reservoir operations and water management, increasing surface water and groundwater storage and conveyance, reducing demand, performing water transfers and purchases, enhancing Delta exports, and constructing water temperature management devices (Table 3-1 through 3-3). Measures addressing secondary planning objectives, which could be implemented in coordination with primary planning objective measure, were grouped according to the specific secondary objectives (Table 3-4).

Of the measures identified, several were selected for development into initial alternatives and alternative plans investigated in this Draft Feasibility Report. Other measures were deleted during Phase 1, the initial alternatives phase, the plan formulation phase, and the Draft Feasibility and Plan Refinement phase of the Investigation. Of 28 measures identified to address both primary planning objectives, 2 were retained for subsequent investigations in this Draft Feasibility Report, and 2 were retained in concept (Table 3-1). Of the 10 measures identified to address only water supply reliability and system operations flexibility, 2 were retained in concept (Table 3-2). Of the four measures identified to enhance water temperature and flow conditions in the San Joaquin River, two were retained for subsequent investigations in this Draft Feasibility Report (Table 3-3). Of 16 measures identified to address secondary planning objectives, 3 were retained for subsequent investigations in this Draft Feasibility Report, and 2 were retained in concept (Table 3-4).

Further detail on the management measures considered, deleted from consideration, and retained, is included in the Plan Formulation Appendix.

Table 3-1. Management Measures Addressing Both Primary Planning Objectives

Measure	Status	Rationale
Perform Reservoir Operations and Water Management		
Modify storage and release operations at Friant Dam	Retained	Potential to combine with other measures involving development of San Joaquin River supplies. Consistent with other planning objective and opportunities. Consistent with CALFED goals. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Increase conservation storage in Millerton Lake by encroaching on dam freeboard	Deleted	Operable gates on the spillway allow for storage in the portion of the top of active storage capacity above the spillway crest. The remaining height to the top of the parapet walls is about 7.5 feet, providing very limited potential to encroach on existing freeboard. This measure was deleted from consideration during the plan formulation phase.
Increase conservation storage in Millerton Lake by reducing flood space	Deleted	The flood management capacity of Friant Dam is lower than originally anticipated. Evaluations suggest that additional flood space would be beneficial in reducing flood damages in downstream areas. Reducing flood space would increase flood damages. This measure was deleted from consideration during the plan formulation phase.
Increase Surface Water Storage in the Upper San Joaquin River Basin		
Enlarge Millerton Lake by raising Friant Dam	Deleted	Raises of up to 140 feet (920 TAF of additional storage) were considered. Evaluations during the initial alternatives phase concluded that this measure would not be carried forward as a stand-alone alternative because the new water supply that could be developed would not likely contribute to planning objectives. A Friant Dam raise of more than 25 feet was deleted from consideration during the initial alternatives phase because it would result in extensive residential relocation, power generation losses, and environmental effects along the San Joaquin River and in the Fine Gold Creek watershed, and was not considered cost effective, compared to other retained water storage measures. A Friant Dam raise of 25 feet combined with one of the other surface water storage measures would not be effective because very limited additional water supply would be provided and because of the impacts to private property and recreation facilities. A dam raise of 25 feet was deleted from consideration during the plan formulation phase.
Enlarge Millerton Lake by dredging lake bottom	Deleted	Very high cost and substantial environmental effects for a small potential benefit. This measure was deleted from consideration during the plan formulation phase.
Construct Temperance Flat RM 274 Reservoir	Retained	Reservoir sizes up to elevation 1,100 feet (2,110 TAF of additional storage) at this site were considered. Retained maximum size at about elevation 985 (1,260 TAF new storage capacity) in IAIR because the incremental new water supply did not appear justified due to substantial additional effects to environmental resources, additional effects to hydropower generation, and higher construction costs. Compared Temperance Flat RM 279 Reservoir alternative plans, Temperance Flat RM 274 Reservoir have greater benefits, greater net benefits, and a higher benefit-cost ratio. This measure was retained through the draft feasibility and plan refinement phase of the Investigation.

Table 3-1. Management Measures Addressing Both Primary Planning Objectives (contd.)

Measure	Status	Rationale
Increase Surface Water Storage in the Upper San Joaquin River Basin (continued)		
Construct Temperance Flat RM 279 Reservoir	Deleted	Reservoir sizes up to elevation 1,300 feet (2,740 TAF of additional storage) at this site were considered. Retained maximum size at about elevation 985 (690 TAF new storage capacity) in IAIR because the incremental new water supply did not appear justified due to substantial additional effects to environmental resources, additional effects to hydropower generation, and higher construction costs. Compared Temperance Flat RM 274 Reservoir alternative plans evaluated during the plan formulation phase, Temperance Flat RM 279 Reservoir alternative plans have lesser benefits, lesser net benefits, and a lower benefit-cost ratio. This measure was deleted during the plan formulation phase of the Investigation.
Construct Temperance Flat RM 280 Reservoir	Deleted	Similar to Temperance Flat RM 279 Reservoir, would result in similar effects on environmental resources, hydropower generation, and water supplies. Total storage capacity would be less and cost would be greater than at RM 279. This measure was deleted during Phase 1 of the Investigation.
Construct Temperance Flat RM 286 Reservoir	Deleted	Reservoir sizes up to elevation 1,400 feet (1,360 TAF of additional storage) at this site were considered. Deleted because environmental effects and net effects to hydropower generation would be greater and construction costs would be similar to comparable storage capacities at other Temperance Flat locations. This measure was deleted during the initial alternatives phase of the Investigation.
Construct Fine Gold Reservoir	Deleted	Reservoir sizes of up to 800 TAF of new storage capacity at this site were considered under configurations that included pumpback from Millerton Lake and/or upstream diversion from San Joaquin River and conveyance to Fine Gold Reservoir in combination with additional upstream storage. Water would be released from Fine Gold Creek Reservoir to Millerton Lake during periods of highest demand for releases from Friant Dam to the San Joaquin River and Friant-Kern and Madera canals. A configuration involving diversion from San Joaquin River in combination with additional upstream storage was deleted during the initial alternatives phase because of substantial impacts to environmental resources and high cost of water supply. Based on relative ability to meet the four P&G criteria, Fine Gold Reservoir surface water storage measure was considered inferior to the Temperance Flat RM 274 and RM 279 surface water storage measures. This measure was deleted during the plan formulation phase of the Investigation.
Enlarge Mammoth Pool Reservoir	Deleted	During the early phases of the Investigation, this measure was under study by the Friant Water Users Authority and Metropolitan Water District of Southern California in a study of water quality exchange opportunities. This measure would have similar costs to Temperance Flat RM 274 but could only provide about half the water supply and therefore, proportionally less benefits. This measure was deleted during the plan formulation phase of the Investigation.

Table 3-1. Management Measures Addressing Both Primary Planning Objectives (contd.)

Measure	Status	Rationale
Increase Surface Water Storage in the Upper San Joaquin River Basin (continued)		
Construct RM 315 Reservoir	Deleted	This reservoir, with a maximum storage capacity of about 200 TAF, would cause greater environmental effects and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as a water supply measure. This measure was deleted during the initial alternatives phase of the Investigation.
Construct Granite Project reservoirs	Deleted	Total storage capacity of about 110 TAF from multiple dams and reservoirs would cause greater environmental effects and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as a water supply measure. This measure was deleted during the initial alternatives phase of the Investigation.
Construct Jackass and Chiquito Creek reservoirs	Deleted	Total storage capacity of about 180 TAF from multiple dams and reservoirs would cause greater environmental effects and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as a water supply measure. This measure was deleted during the initial alternatives phase of the Investigation.
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds		
Construct Montgomery Reservoir	Deleted	An off-stream reservoir with a storage capacity of up to about 240 TAF on Dry Creek would store water diverted from the Merced River and provide water in exchange for Friant Division deliveries. Potential exchange partners were not interested in a water supply with potential water quality problems, such as algae, associated with warm water. This measure was deleted during Phase 1 phase of the Investigation.
Modify Big Dry Creek Reservoir for water storage	Deleted	Modifications to the Big Dry Creek Reservoir would allow for water storage. A zoned earthfill embankment dam could create a reservoir with approximately 30 TAF of storage; however, due to seepage concerns and insufficient inflow, the total storage capacity has not been tested. Consequently, uncertainty remains regarding the existing dam's ability to store more than a few TAF of water. Modifications to enable long-term storage may require extensive reconstruction. This measure was deleted during Phase 1 of the Investigation.
Enlarge Pine Flat Lake by raising Pine Flat Dam	Deleted	Water stored in about 120 TAF of additional storage space in Pine Flat Lake would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. This measure was deleted during Phase 1 of the Investigation.
Construct reservoir on Mill Creek	Deleted	Water diverted from Pine Flat Reservoir and stored in this new off-stream reservoir with a storage capacity of up to 200 TAF would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure could cause immitigable environmental effects to sycamore alluvial woodland habitat. This measure was deleted during Phase 1 of the Investigation.

Table 3-1. Management Measures Addressing Both Primary Planning Objectives (contd.)

Measure	Status	Rationale
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds (continued)		
Construct Rogers Crossing Reservoir on the Kings River	Deleted	Water stored in Rogers Crossing Reservoir, with a storage capacity of up to 950 TAF, would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure would inundate a federally designated Wild and Scenic River and a California-designated Wild Trout Fishery. This measure was deleted during Phase 1 of the Investigation.
Construct Dinkey Creek Reservoir on a tributary to the Kings River	Deleted	Water stored in Dinkey Creek Reservoir, with a storage capacity of up to 90 TAF, would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure would cause substantial adverse effects to regional transportation and adversely affect high-value fishery areas in downstream areas. This measure was deleted during Phase 1 of the Investigation.
Construct Dry Creek Reservoir on a tributary to the Kaweah River	Deleted	Water diverted from Lake Kaweah and stored in a 70 TAF offstream reservoir would be exchanged for Friant Division deliveries. This measure could cause immitigable environmental effects to sycamore alluvial woodland habitat. This measure was deleted during Phase 1 of the Investigation.
Raise Terminus Dam	Deleted	Previously authorized for construction by the U.S. Army Corps of Engineers; the dam raise was completed in 2004. This measure was deleted during Phase 1 of the Investigation.
Raise Success Dam	Deleted	Previously authorized for construction by the U.S. Army Corps of Engineers; the dam raise was cancelled in 2011 due to seismic concerns. This measure was deleted during Phase 1 of the Investigation.
Construct Tulare Lake Storage and Conveyance Facilities	Deleted	Development of reservoir storage in the Tulare Lake bed to store flood flows from eastside rivers and recirculated supplies for use as an integrated surface water and groundwater storage facility. Substantial institutional arrangements and limitations to the use of water supplies transferred and stored in Tulare Lake. This measure was deleted during the plan formulation phase of the Investigation.
Increase Surface Water Storage off the Friant-Kern Canal		
Construct reservoir in Yokohl Valley	Deleted	A new reservoir with a capacity of up to about 800 TAF would store water conveyed from Millerton Lake via the Friant-Kern Canal. Deleted because of conveyance limitations in the Friant-Kern Canal, potential that water quality problems associated with warm water would preclude water transfers, potential environmental effects, and likely low willingness of local landowners to participate. This measure was deleted during the initial alternatives phase of this Investigation.
Construct Hungry Hollow Reservoir on Deer Creek	Deleted	A new reservoir with a capacity of up to about 800 TAF would store water conveyed from Millerton Lake via the Friant-Kern Canal. Deleted because of potential high costs associated with poor foundation conditions, conveyance limitations in the Friant-Kern Canal, and the presence of a potentially immitigable sycamore alluvial woodland habitat. This measure was deleted in Phase 1 of the Investigation.

Table 3-1. Management Measures Addressing Both Primary Planning Objectives (contd.)

Measure	Status	Rationale
Increase Groundwater Storage		
Increase conjunctive management of water in the Friant Division	Retained in Concept Only	Conjunctive management in the Friant Division occurs by increasing groundwater recharge with additional Class 2 deliveries or the development of local surface water supplies. Potential to combine with other measures involving development of San Joaquin River supplies, such as increasing surface water storage in the upper San Joaquin River Basin. Because specific potential conjunctive management projects have not been identified, this measure was retained in concept only through the draft feasibility and plan refinement phase of the Investigation.
Construct and operate groundwater banks in the Friant Division	Retained in Concept Only	Groundwater banks operated as allocable water supplies in the Friant Division could provide water for river releases. Because specific potential projects have not been identified, this measure was retained in concept only retained in concept only through the draft feasibility and plan refinement phase of the Investigation.

Key:
CALFED = CALFED Bay-Delta Program
elevation xxxx = elevation in feet above mean sea level
IAIR = Initial Alternatives Information Report (Reclamation 2005b)
RM = river mile
TAF = thousand acre-feet

Table 3-2. Management Measures Addressing Primary Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility

Measure	Status	Rationale
All Measures Listed in Table 3-1	Retained/Deleted	All measures listed in Table 3-1 also address the Planning Objective of increasing water supply reliability and system operational flexibility
Perform Reservoir Operations and Water Management		
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division	Retained in Concept Only	Integrating operations of Friant Division facilities with SWP and/or CVP facilities through water exchanges could improve water supply reliability and urban water quality. Opportunities with existing facilities are limited. Potential to combine with other measures relating to increasing surface water storage in the upper San Joaquin River Basin. This measure was retained in concept only through the Draft Feasibility and Plan Refinement Phase because operating conditions under the 2008/2009 BOs make integration less feasible. Integration opportunities under alternate future conditions with more flexible CVP and SWP Delta export operations may be assessed in the Final Feasibility Report.
Modify diversion to Madera and Friant-Kern canals	Retained in Concept Only	Modifying the timing and quantity of water diverted to Madera and Friant-Kern canals would increase water supply reliability to Friant Division contractors and may provide opportunities for groundwater banking. Would support planning objectives. Because specific operations for groundwater banking have not been defined, this measure is retained in concept only through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Capture downstream San Joaquin River flow released from Friant Dam	Deleted	Downstream capture of regulated San Joaquin River flows could increase water supply reliability in the Friant Division of the CVP, other CVP service areas, and SWP. This measure deleted because it is the subject of separate evaluation by the SJRRP.
Reduce Water Demand		
Implement water conservation and water use efficiency methods in excess of those in the without-project condition	Deleted	Opportunities to apply large-scale water conservation measures in the Friant Division are limited because conveyance losses and excess water application returns to groundwater for use in subsequent years. This measure was deleted during the plan formulation phase of the Investigation.
Retire agricultural lands	Deleted	Does not address planning objectives and consideration/criteria. On a large scale, could have substantial negative effects on agricultural industry. This measure was deleted during the plan formulation phase of the Investigation.
Increase Transvalley Conveyance Capacity		
Construct Trans Valley Canal	Deleted	Potential to combine with other measures, including integration of Friant Dam operations with CVP and SWP, and increasing surface water storage in the upper San Joaquin River Basin. This measure was deleted during the plan formulation phase of the Investigation.

Table 3-2. Management Measures Addressing Primary Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility (contd.)

Measure	Status	Rationale
Perform Water Transfers and Purchases		
Transfer water between Friant Division water users	Deleted	Does not address planning objectives or considerations/criteria. An ongoing practice among Friant Division water users to maximize use of Friant Division water deliveries. This measure was deleted during the plan formulation phase of the Investigation.
Enhance Delta Export and Conveyance		
Expand Banks Pumping Plant	Deleted	Does not address planning objectives or considerations/criteria. Would likely be accomplished with or without additional efforts to develop new sources. This measure was deleted during the plan formulation phase of the Investigation.
Construct DMC/CA Intertie	Deleted	Currently under construction. This measure was deleted during the plan formulation phase of the Investigation.
Improve Delta export and conveyance capability through coordinated CVP and SWP operations	Deleted	JPOD is being actively pursued in other programs. This measure was deleted during the plan formulation phase of the Investigation.

Key:
Banks Pumping Plant = Henry O. Banks Pumping Plan
CVP = Central Valley Project
DMC/CA = Delta Mendota Canal/California Aqueduct
JPOD = joint point of diversion
SJRRP = San Joaquin River Restoration Program
SWP = State Water Project

Table 3-3. Management Measures Addressing Primary Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River

Measure	Status	Rationale
All Measures Listed in Table 3-1	Retained/Deleted	All measures listed in Table 3-1 also address the Planning Objective of enhancing water temperature and flow conditions in the San Joaquin River
Perform Reservoir Operations and Water Management		
Balance water storage in Millerton Lake and new upstream reservoirs	Retained	Balancing water storage levels between multiple reservoirs could improve water temperature management and affect hydropower generation and recreation. This measure was retained through the draft feasibility and plan refinement phase of the Investigation.
Construct Water Temperature Management Devices		
Construct temperature control devices on Friant Dam canal outlets	Deleted	Selective withdrawal of warm water for releases to the Madera and Friant-Kern canals from upper levels of Millerton Lake could conserve cold water in Millerton Lake, but does not manage cold water in reservoirs upstream from Millerton Lake. This measure was deleted during the plan formulation phase of the Investigation.
Construct temperature control device on Friant Dam river outlet	Deleted	Selective withdrawal of warm water for releases to the San Joaquin River could improve the management of cold water in Millerton Lake, but does not manage cold water in reservoirs upstream from Millerton Lake. This measure was deleted during the plan formulation phase of the Investigation.
Construct selective level intake structures on new upstream dams	Retained	Selective withdrawal of cold or warm water for releases to Millerton Lake from new upstream reservoirs could help manage cold water in Millerton Lake and provides flexibility in managing cold water in potential reservoirs upstream from Millerton Lake. This measure was retained through the draft feasibility and plan refinement phase of the Investigation.

Table 3-4. Management Measures Addressing Secondary Planning Objectives

Measure	Status	Rationale
Reduce Frequency and Magnitude of Flood Releases from Friant Dam		
Change objective flood release from Friant Dam	Deleted	Specific operations have not been defined, and in general, the potential flood risk management benefits resulting from a change in the objective flood release from Friant Dam are obtained incidentally through implementing the Temperance Flat Reservoir measures. This measure was deleted during the plan formulation of the Investigation.
Increase flood storage space in or upstream from Millerton Lake	Retained	May be compatible with the planning objectives. Would not conflict with other opportunities or planning constraints/criteria. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Maintain the Value of Hydropower Attributes		
Modify existing or construct new generation facilities at Friant Dam canal outlets	Deleted	Measures addressing opportunities associated with the Enlarge Millerton Lake measure, such as modified or new generation facilities at Friant Dam canal outlets, are not being considered for further evaluation in the Investigation. This measure was deleted during the plan formulation phase of the Investigation.
Modify existing or construct new generation facilities at Friant Dam river outlet	Deleted	Orange Cove Irrigation District filed on April 19, 2006, requesting Federal Energy Regulatory Commission approval of an amendment of license for the Fishwater Release Project to add a powerhouse with a single turbine generator with a capacity of 1.8 megawatts. This measure was deleted during the plan formulation phase of the Investigation.
Construct new hydropower generation facilities on new surface water storage measures	Retained	Would increase the capability to recover lost generation capacity at each retained Temperance Flat Reservoir site. Would not conflict with other opportunities or planning constraints/criteria. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Extend Kerckhoff tunnels around new surface water storage measures	Deleted	Would involve extending the Kerckhoff No. 2 tunnel and constructing a new powerhouse downstream from either the Temperance Flat RM 279 or RM 274 dam sites. Would increase capability to recover lost generation. This measure was deleted during the Draft Feasibility and Plan Refinement Phase of the Investigation because the flow capacity and energy generation potential were considered too low to justify the expense.
Construct pumped-storage facilities	Deleted	Could be combined with hydropower generation facilities associated with Temperance Flat reservoirs. Would require participation by a non-Federal partner with an interest in power development and management. This measure is less cost effective than constructing conventional hydropower generation facilities alone, and was deleted during the Draft Feasibility and Plan Refinement Phase of the Investigation.
Maintain and Increase Recreation Opportunities in the Primary Study Area		
Replace or upgrade recreation facilities	Retained	Compatible with any potential modification of Millerton Lake. Would be consistent with established planning guidelines for Federal water storage projects and with existing recreation uses at Millerton Lake State Recreation Area. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Develop new management plan for Millerton Lake State Recreation Area	Deleted	Millerton Lake Resource Management Plan/General Plan was published by Reclamation in 2012 under a separate study. This measure was deleted during the plan formulation phase of the Investigation.

Table 3-4. Management Measures Addressing Secondary Planning Objectives (contd.)

Measure	Status	Rationale
Improve San Joaquin River Water Quality Downstream from Friant Dam		
Reduce salt discharge to San Joaquin River	Deleted	Currently being implemented under the San Joaquin Valley Drainage Management Program. This measure was deleted during the plan formulation phase of the Investigation.
Recirculate Delta-Mendota Canal deliveries to the San Joaquin River	Deleted	Would increase flows and could improve water quality from Mendota Pool to the Delta. Would not provide flows in the reach from Friant Dam to Mendota Pool. Independent ongoing study authorized by Public Law 108-573. This measure was deleted during the plan formulation phase of the Investigation.
Increase flows in tributaries to lower San Joaquin River	Deleted	Would increase flows and improve water quality from Mendota Pool to the Delta, but would not provide flows to the reach from Friant Dam to Mendota Pool. This measure was deleted during the plan formulation phase of the Investigation.
Release water from Friant Dam to improve river water quality	Deleted	Conflicts with planning objective of increasing water supply reliability. This measure was deleted during the plan formulation phase of the Investigation.
Improve Quality of Water Supplies Delivered to Urban Areas		
Treat poor quality groundwater	Deleted	High implementation costs, limited application and benefits. This measure was deleted during the plan formulation phase of the Investigation.
Integrate Friant Dam operations with SWP and/or CVP outside the Friant Division	Retained in Concept Only	Same as described in Table 3-2.
Construct desalination facility	Deleted	Limited application as a dry-year supply, high unit cost, and potential environmental effects from treatment byproducts. This measure was deleted during the plan formulation phase of the Investigation.

Key:
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
RM = river mile
SWP = State Water Project

In the discussion of management measures, the term "enhancement" specifically refers to restoration actions that improve environmental conditions above the future without-project condition. Correspondingly, the term "mitigation" refers to restoration actions that compensate or offset project impacts, returning conditions back to a similar level as the future without-project condition. The relationship among restoration, enhancement, and mitigation is illustrated in Figure 3-2.

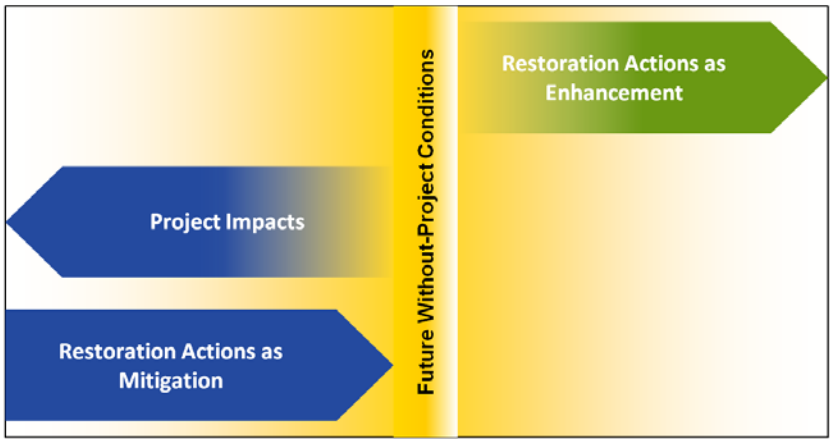

Figure 3-2. Conceptual Schematic of Restoration Actions as Enhancement Versus Restoration Actions as Mitigation

It should be noted that measures that did not directly address the planning objectives, or were otherwise dropped from consideration and further development as alternative plan components under certain circumstances, may be incorporated into alternative plans as mitigation measures. This is primarily because some measures may be found potentially effective in mitigating adverse impacts.

Measures Retained for Inclusion in Draft Feasibility Report Alternative Plans

Measures retained through the Draft Feasibility and Plan Refinement Phase for further consideration in Draft Feasibility Report alternative plans are summarized below.

Measures Addressing Both Primary Planning Objectives

Measures retained that address both primary planning objectives of the Investigation include those that fall under the categories of Perform Reservoir Operations and Water Management, and Increase Surface Water Storage in the Upper San Joaquin River Basin, as summarized in Table 3-1.

Additionally, measures to increase groundwater storage retained in concept only are described.

Modify Storage and Release Operations at Friant Dam
This measure would include modifications to storage and release operations at Friant Dam. These operational modifications would be intended to optimize the existing system of reservoirs. In addition, this measure may be combined with other measures involving developing water supplies in the upper San Joaquin River Basin to enhance San Joaquin River water temperature and flow conditions and increase water supply reliability.

Construct Temperance Flat RM 274 Reservoir
During previous phases of the Investigation, several potential surface water storage sites in the upper San Joaquin River Basin were identified and evaluated for potential inclusion in alternatives (Reclamation 2003, 2005b, and 2008a). Multiple sizes and configurations were considered at several sites. Evaluations considered water supply operations, general environmental consequences, construction costs, and energy generation and use. Locations of each of the 22 surface water storage measures considered are shown in Figure 3-3.

Evaluations conducted during the plan formulation phase led to selection of the Temperance Flat RM 274 Reservoir as the preferred surface water storage measure for further development and inclusion in alternative plans in the Draft Feasibility and Plan Refinement Phase. Temperance Flat RM 274 Reservoir would include construction of a dam in the upstream portion of Millerton Lake at RM 274. The dam site is located approximately 6.8 miles upstream from Friant Dam and 1 mile upstream from the confluence of Fine Gold Creek and Millerton Lake. With a top-of-active-storage capacity at elevation 985, Temperance Flat RM 274 Reservoir would provide 1,260 TAF of new storage capacity and extend about 18.5 miles upstream from RM 274 to Kerckhoff Dam. At top-of-active-storage capacity, the reservoir level would reach about 12 feet below the crest of Kerckhoff Dam. Reservoir sizes up to elevation 1,100 at this site were considered in previous phases of the Investigation. Reservoir sizes corresponding to elevations higher than elevation 985 were not retained because the incremental new water supply provided did not appear justified in light of substantial additional effects to environmental resources, additional effects to hydropower generation, and higher construction costs (Reclamation 2005b).

Historical Dam Site Selection

Almost 84 years ago, Hyde Forbes, an engineering geologist, issued a geological report on three potential dam sites on the San Joaquin River for the State of California. The report evaluated geologic conditions at the Friant, Fort Miller, and Temperance Flat (RM 274) sites. The geologic study contributed to planning efforts that led to construction of Friant Dam (Forbes 1930).

From a water storage perspective, the RM 274 site was considered superior to the two other sites, but the Friant location was selected because constructing a dam at RM 274 would have required extending canals around or through the current Millerton Lake area, or constructing a second dam at Friant for diverting water to the canals (Reclamation 2003).

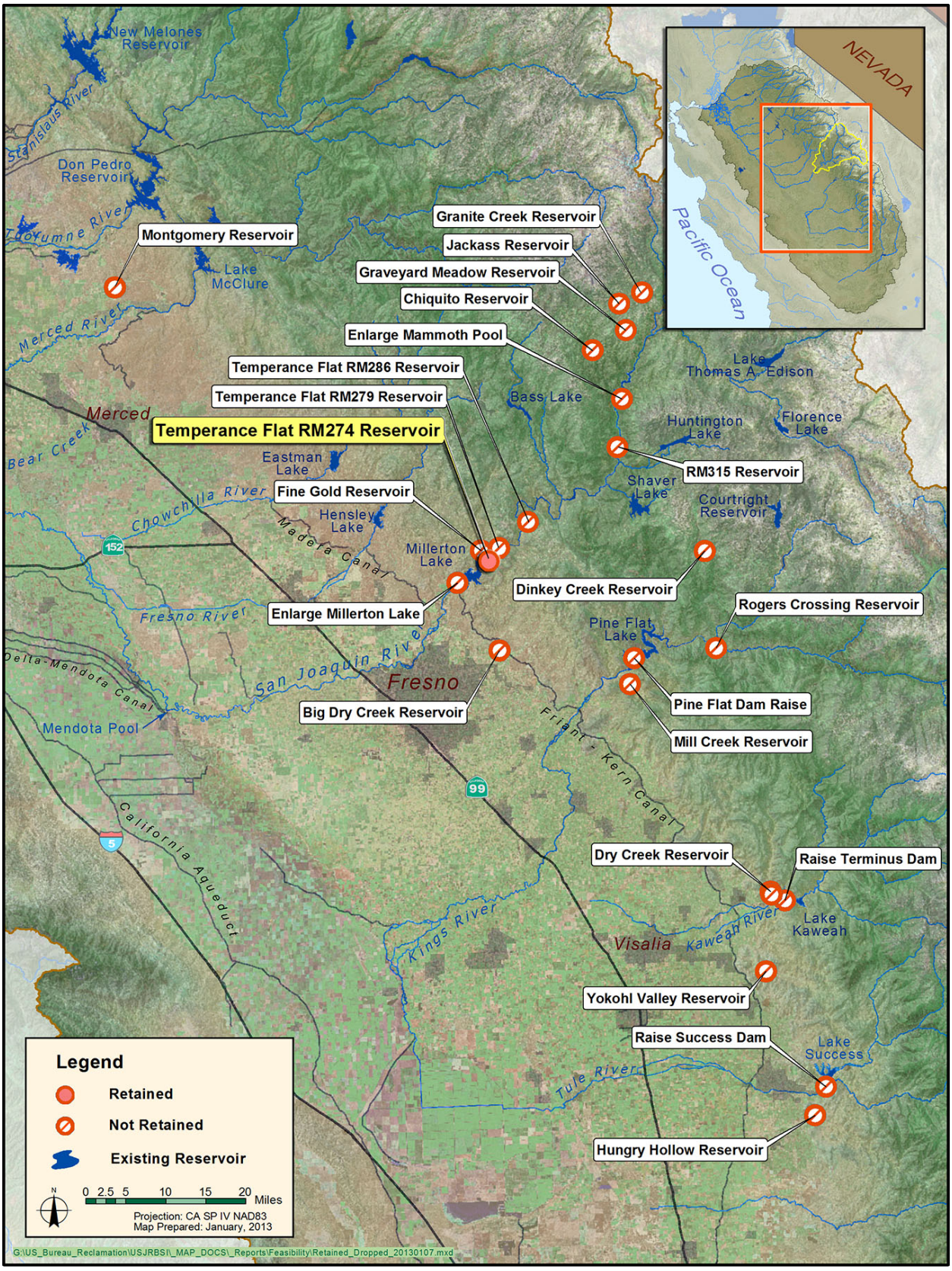

Figure 3-3. Surface Water Storage Measures Considered

Increase Conjunctive Management of Water in the Friant Division and Construct and Operate Groundwater Banks in the Friant Division

Several assumptions were applied to assess the reasonable amount of additional water from Millerton Lake that could be stored in San Joaquin Valley groundwater basins with no additional surface water storage. When canal conveyance limitations and exhibited historical preferences for delivery of water during wet conditions were represented, it was found that an upper limit of about 50 TAF per year of additional groundwater recharge could be possible. It should be noted that local stakeholders have indicated a preference to use conjunctive management projects to meet local water needs first, a preference that is also stated in the CALFED ROD (2000a).

During plan formulation, DWR conducted a San Joaquin Valley Conjunctive Water Management Opportunities analysis and identified several potential conjunctive management or groundwater storage projects in the San Joaquin Valley that could be considered in any regional water resources study (DWR 2006b). Fifteen potential groundwater storage projects in the San Joaquin Valley were identified that appear to have high potential for implementation. Recommended potential conjunctive management and groundwater storage projects are located in Madera, Kings, and Kern county groundwater basins (DWR 2006b). These potential projects have not yet been evaluated to determine their ability to contribute to Investigation objectives, and would require considerable additional data development for site-specific analysis. Thus, the measures related to increasing groundwater storage were retained in concept only and are further described in the Plan Formulation Appendix.

Measures Specifically Addressing Increasing Water Supply Reliability and System Operational Flexibility

Measures retained that specifically address the primary planning objective of increasing water supply reliability and system operational flexibility include those that perform reservoir operations and water management.

B.F. Sisk Dam and San Luis Reservoir

Operation of San Luis Reservoir, a joint CVP/SWP facility, could be integrated with new upper San Joaquin River Basin storage to improve water supply reliability.

Integrate Friant Dam Operations with State Water Project and/or Central Valley Project outside Friant Division

Integration of Friant Dam operations with the SWP and CVP outside the Friant Division could provide opportunities for exchange of water supplies, allowing greater optimization of system operations for improved water supply reliability and improved water quality of supplies delivered to urban areas. Water supply reliability improvements may be limited by available conveyance capacity in existing trans-valley conveyance facilities and available SOD storage capacity. Increasing surface water storage in the upper San Joaquin River Basin, along with expansion of existing conveyance facilities and/or construction of additional trans-valley conveyance, would substantially increase potential water supply. Operating conditions under the 2008/2009 BOs, however, make integration less feasible, and this measure is not evaluated in the Draft Feasibility Report. Alternate future conditions with more flexible CVP and SWP Delta export operations would likely result in significantly greater estimates of water supply reliability from Temperance Flat RM 274 Reservoir (see Plan Formulation Report, Reclamation 2008a) and may be assessed in future studies. Thus, the integration measure was retained in concept only.

Modify Diversion to Madera and Friant-Kern Canals

This measure would involve modifying the timing and quantity of water diverted to Madera and Friant-Kern canals, which would increase water supply reliability to Friant Division contractors and may provide opportunities for groundwater banking. This measure would support planning objectives; however, because specific operations for groundwater banking have not been defined, this measure is retained in concept only.

Measures Specifically Addressing Enhancing Water Temperature and Flow Conditions

Measures retained that specifically address the primary planning objective of enhancing water temperature and flow conditions include those that (1) perform reservoir operations and water management, and (2) construct water temperature management devices.

Balance Water Storage in Millerton Lake and New Upstream Reservoirs

The management of water supplies between Millerton Lake and additional upstream surface water storage in the upper San Joaquin River Basin could affect water supply, water temperature management, hydropower generation, and recreation. Reservoir-balancing scenarios were developed for surface water storage measures in the upper San Joaquin River Basin during the plan formulation phase, and these reservoir-balancing scenarios were refined in the Draft Feasibility and Plan Refinement Phase of the Investigation.

Construct Selective Level Intake Structures on New Upstream Dams

Selective level intake structures (SLIS) could be constructed on the intakes for dams associated with measures to increase surface water storage in the upper San Joaquin River Basin. The SLIS would allow selective withdrawal of cold or warm water from these upper reservoirs for temperature management, thereby contributing to restoration of the San Joaquin River by enhancing temperature conditions for species that require cold water during specific life stages.

Measures Addressing Secondary Planning Objectives

Measures retained that address secondary planning measures include those that improve management of flood flows at Friant Dam, maintain and increase energy generation and improve energy generation management, maintain and increase recreation opportunities in the study area, and improve quality of water supplies delivered to urban areas. Descriptions of measures that also apply to primary planning objectives are not repeated in this section.

Increase Flood Storage Space in or Upstream from Millerton Lake

Development of additional storage for water supply provides opportunities for additional dedicated or incidental flood storage space. Evaluations completed during the Initial Alternatives Phase considered the benefits associated with additional dedicated flood space in or upstream from Friant Dam (Reclamation 2005b).

Construct New Hydropower Generation Facilities on Retained New Surface Water Storage Measures

The construction of new surface water storage facilities presents an opportunity to add hydropower generation facilities and improve energy generation management in the study area.

Replace or Upgrade Recreational Facilities
Implementation of surface water storage and reservoir operations measures would affect existing recreational facilities at Millerton Lake. This measure includes developing suitable replacement facilities, with necessary upgrades to meet current standards and codes, to provide similar or greater recreational opportunities. It is recognized that some recreational experiences, such as whitewater rafting and caving, may not be replaceable for some alternatives.

Draft Feasibility Report Measures Summary
Alternative plans considered in the Draft Feasibility Report fundamentally consist of constructing new surface water storage facilities and operating them primarily to address the primary planning objectives of increasing water supply reliability and enhancing temperature and flow conditions in the San Joaquin River. Measures to address secondary planning objectives were also included in alternative plans (Table 3-5). Measures that were retained in concept only, such as increasing groundwater storage, are not explicitly included in alternative plans evaluated in the Draft Feasibility Report because of a lack of specific information needed to evaluate the measures further.

Table 3-5. Management Measures Retained for Alternative Plans in Draft Feasibility Report

Planning Objective	Resources Management Measure	
	Feature/Activity	**Description**
Primary Planning Objectives		
Increase Water Supply Reliability and Enhance Water Temperature and Flow Conditions	Construct Temperance Flat River Mile 274 Reservoir	Increase surface water storage capacity by constructing dam in upstream portion of Millerton Lake at River Mile 274
	Modify Storage and Release Operations at Friant Dam	Optimize existing system of reservoirs by modifying Friant Dam operations
Enhance Water Temperature and Flow Conditions	Balance Water Storage in Millerton Lake and New Upstream Reservoirs	Manage water levels and targets between Millerton Lake and new reservoir
	Construct Selective Level Intake Structures on New Upstream Dams[1]	Selectively withdraw cold or warm water from new reservoir

Table 3-5. Management Measures Retained for Alternative Plans in Draft Feasibility Report (contd.)

Planning Objective	Resources Management Measure	
	Feature/Activity	Description
Secondary Planning Objectives		
Reduce Flood Releases from Friant Dam	Increase Flood Storage Space in or Upstream from Millerton Lake	Increase incidental flood storage space by constructing dam in upstream portion of Millerton Lake at River Mile 274
Maintain Hydropower Attributes Value	Construct New Hydropower Facilities on Retained New Surface Water Storage Measures	Generate hydropower with new powerhouse using releases from new reservoir
Maintain/Increase Recreational Opportunities	Replace or Upgrade Recreational Facilities	Develop replacement facilities to provide similar or greater recreational opportunities at Millerton Lake and new reservoir

Draft Feasibility and Plan Refinement Phase

This section provides additional detail and context regarding the measures selected for inclusion in the Draft Feasibility Report alternative plans, and rationale for some of the measures and options considered and deleted during plan refinement. It should be noted that mitigation measures have not been completely identified at this stage in the Investigation and will be further developed for the Final Feasibility Report and EIS/EIR.

Evaluations conducted during previous phases of the Investigation and documented in the Phase 1 Investigation Report (Reclamation 2003), IAIR (Reclamation 2005b), and Plan Formulation Report (PFR) (Reclamation 2008a) led to the selection of the Temperance Flat RM 274 Reservoir as the preferred surface water storage site for further development and inclusion in alternative plans in the Draft Feasibility and Plan Refinement Phase. Previous phases of the Investigation evaluated 22 separate storage sites, in addition to the 52 sites considered in the CALFED Initial Surface Water Storage Screening (2000b) (See Figure 3-4).

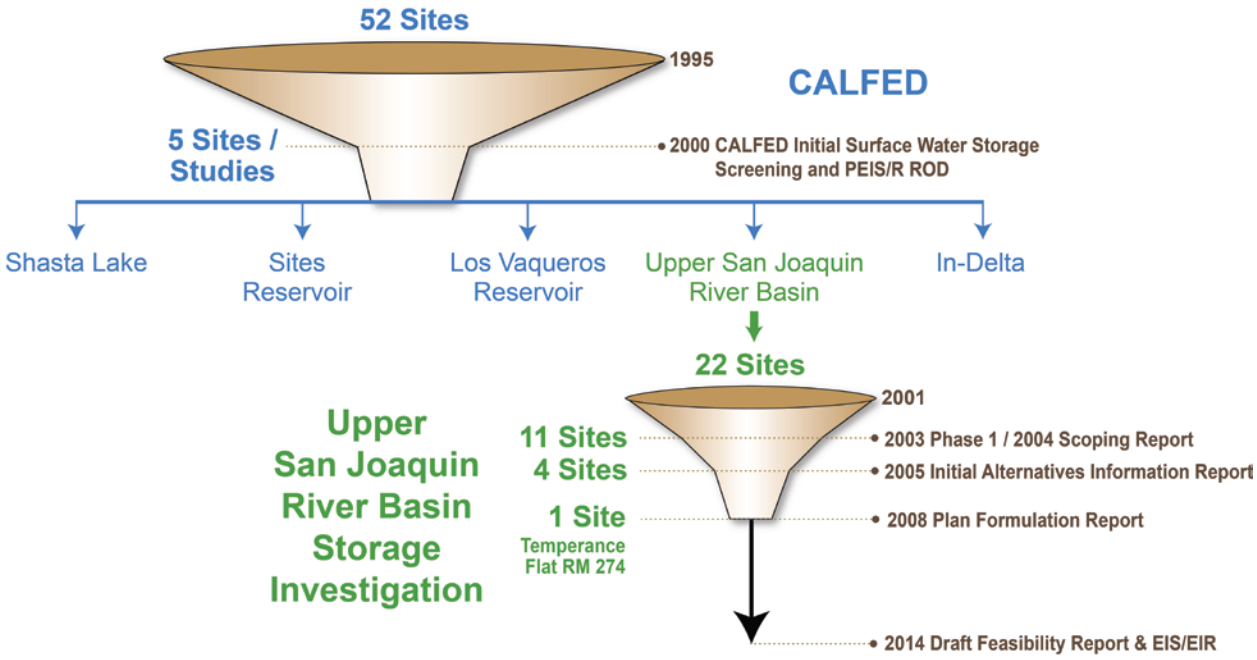

Figure 3-4. CALFED and Investigation Process Leading to Selection of Temperance Flat RM 274 Reservoir Site

Since selection of Temperance Flat RM 274 Reservoir for feasibility analysis, various planning activities have taken place to study a range of potential alternative variations at the site. Temperance Flat RM 274 Reservoir was evaluated under a range of operational priorities, beneficiaries, and feature configurations to illustrate trade-offs in the plan formulation process and test the sensitivity of alternative plan accomplishments, benefits, and costs to the various conditions. The following sections describe project feature refinements and iterations of potential operation scenarios that led to development of alternative plans described in Chapter 4.

Physical Features Development Process for Alternative Plans

Several engineering studies have been performed for the Draft Feasibility and Plan Refinement Phase of the Investigation to support development of Temperance Flat RM 274 Reservoir alternatives. This section summarizes development of the main physical features of alternatives: Temperance Flat RM 274 Dam and appurtenant structures, diversion and outlet works, hydropower generation features, and temperature management features. Further details on site engineering and features are included in the Engineering Summary Appendix.

Dam and Appurtenant Structures

The PFR included alternatives with an embankment dam type; however, Reclamation reevaluated both embankment and roller-compacted concrete (RCC) dam types and recommended the RCC dam type for development of feasibility-level designs at the Temperance Flat RM 274 Dam site (Reclamation 2009a). A value planning study was conducted in 2011 to identify potential means and methods to reduce costs on all engineering features while meeting planning objectives. Proposals specific to the dam included assessment of a thinner straight RCC dam, a curved RCC dam, and a new spillway configuration (Reclamation 2011c). Considering the construction method for RCC, a single center arch dam layout was determined to be most appropriate for the Temperance Flat RM 274 Dam site (Reclamation 2013b).

Diversion and Outlet Works

After the PFR, updated flood routings prompted a refinement of the diversion-during-construction concept to use two rockfill cofferdams, two RCC cofferdams, a diversion notch in the left abutment of the RCC dam, and a 30-foot-diameter tunnel in the Big Bend area (tunnel would be used for diversion and river outlet works permanent releases) (Reclamation 2009b, 2010b). The value planning study concluded that the 30-foot diversion tunnel and rockfill cofferdams built to elevation 580 would be sufficient for a 10-year return period flood. The cofferdams were also designed to withstand larger floods and overtopping in the event that becomes necessary during construction, eliminating the need for the diversion notch and RCC cofferdams (Reclamation 2013b).

Hydropower Generation

Initial PFR appraisal-level designs for hydropower generation included an extended Kerckhoff No. 2 Powerhouse tunnel to supply water from Kerckhoff Dam to the proposed powerhouse (Reclamation 2008a). Further assessment of the powerhouse design in the Draft Feasibility and Plan Refinement Phase included two power options: Power Option 1, consisting of two turbines for hydropower generation using water released from Temperance Flat RM 274 Reservoir; and Power Option 2, consisting of one turbine and an extended Kerckhoff No. 2 Powerhouse tunnel for hydropower generation using water released from Kerckhoff Lake, and one turbine for hydropower generation using water released from Temperance Flat RM 274 Reservoir. This assessment incorporated additional appraisal-level design data, refining layouts and design concepts, and

establishing a cost range for power mitigation planning purposes within constraints of water supply operations.

The value planning study had proposals specific to hydropower generation, including evaluating viability of onsite power facilities, and consolidating the powerhouse to the downstream toe of the dam. Hydroelectric pumped-storage facilities were considered during the value planning study; however, were rejected because it is uneconomical given the variability in operations and head range (Reclamation 2011c). The design team also rejected the proposal to relocate the powerhouse to the toe of the dam because it would create congestion and schedule limitations at the construction site (Reclamation 2013b). Additional economic evaluations were performed in the Draft Feasibility and Plan Refinement Phase to reinforce the viability of onsite power facilities, which are considered as necessary mitigation to meet the project objectives.

Reclamation selected Power Option 1 as the preferred onsite hydropower mitigation option for feasibility-level designs (see Attachment D of the Engineering Summary Appendix). Power Option 2 was eliminated from further consideration in the Investigation because it was found to be less cost effective than Power Option 1 in meeting mitigation requirements. In addition to Power Option 1, some alternatives will include additional power mitigation costs to fully mitigate the Kerckhoff Hydroelectric Project value.

Intake Structure and Temperature Management

The PFR included consideration of temperature control devices (TCD) on Friant Dam and an SLIS at Temperance Flat RM 274 Reservoir. Additional study during the Draft Feasibility and Plan Refinement Phase showed that an SLIS at Temperance Flat Reservoir would be more effective for cold-water pool management than a TCD at Friant Dam. The value planning study also proposed assessing the need for temperature management (Reclamation 2011c). The incremental benefits and costs of an SLIS were evaluated using field costs and an economic benefit analysis for temperature improvements. Operations considered included a range of minimum carryover storage targets, and it was determined that the SLIS would be the most effective under alternatives with higher Temperance Flat RM 274 Reservoir minimum carryover storage targets. For lower minimum carryover alternatives, the SLIS cost was not as cost effective, and a low-level intake structure (LLIS) was included in the design (Reclamation 2013b).

Other Construction Areas

Since the PFR designs, access and haul road alignments were updated to account for changes in locations of permanent facilities and construction phasing of diversion tunnel, outlet works, valve house, and powerhouse. Changes to other construction areas, such as the aggregate quarry, batch plant, and staging area were minimal.

Affected Existing Infrastructure

An appraisal-level assessment was performed during the feasibility phase to protect Millerton Lake shoreline recreational facilities from inundation, modify facilities to replace affected areas (i.e., relocate facilities on site), or abandon facilities and replace them at other suitable sites (i.e., relocate facilities off site). Reclamation also developed and refined features to replace affected recreational facilities in the SJRGMA. An assessment of impacts to various local utilities was also performed during this phase of the Investigation.

Operations Development Process for Alternative Plans

Operations were refined after the PFR during the Draft Feasibility and Plan Refinement Phase, which included evaluation of several potential operation assumptions. A range of values for each assumption was explored to assess how well they accomplished planning objectives and criteria. The major categories of operation assumptions included:

- Minimum carryover storage targets in Millerton Lake and Temperance Flat RM 274 Reservoir
- Hydropower options
- Temperature management options
- Water supply beneficiaries (Friant Division, CVP SOD contractors, CVP wildlife refuges, SWP M&I contractors)

In this report, the term **carryover** refers to the minimum storage target maintained in Millerton Lake and/or Temperance Flat RM 274 Reservoir for multiple purposes.

Minimum carryover storage is assumed not to be delivered for water supply; it would be maintained for public benefits such as cold-water pool, recreation, and emergency water supply, as well as providing a minimum pool for hydropower.

Operation assumptions were combined into a number of preliminary alternatives, which were then evaluated to better understand the inter-relationships and impacts on planning objectives and criteria from various combinations of assumptions. Based on analysis results, alternative plans were then developed for evaluation in this Draft Feasibility Report. The operations variables and reservoir sites considered in each phase of the Investigation analysis are summarized and outlined in Table 3-6.

Table 3-6. Sites and Operations Variables Considered in Each Phase of Analysis

Phase of Operations Analyses		Phase 1 and IAIR	Plan Formulation Report	Draft Feasibility and Plan Refinement Phase		
				Operation Assumption Evaluation	Operation Assumption Refinement	Draft Feasibility Report
Reservoir Sites		22 sites	4 sites[1]	Temperance Flat RM 274		
Operations Scenarios		N/A	N/A	30+ scenarios	10+ scenarios	4 alternative plans + No Action
Operations Variables	Minimum Carryover Storage target/ Reservoir-Balancing between Millerton Lake and Temperance Flat	Comparative General Estimate of New Water Supply	Various sizing and balancing configurations	Temperance Flat minimum carryover storage target 100–700 TAF	Temperance Flat minimum carryover storage target 200–450 TAF	Temperance Flat minimum carryover storage target 200–325 TAF
				Millerton Lake minimum carryover storage target 220–445 TAF	Millerton Lake minimum carryover storage target 340 TAF	Millerton Lake minimum carryover storage target 340 TAF
	New Water Supply Beneficiaries		Friant and SWP/CVP (through integration)[2]	Friant/SWP/ CVP Refuges	Friant/SWP/ CVP Refuges	Friant/SWP/CVP SOD/ CVP refuges
	New Water Supply Routing Options		Included potential transvalley conveyance	Generalized analysis; not investigated	FKC (Friant and SWP) SJR (SWP and CVP)	FKC (Friant and SWP) SJR (SWP and CVP)
	Temperature Management		Comparative estimates of cold water volume	TCD/SLIS	SLIS	SLIS on high carryover storage alternative plans
	Hydropower Mitigation	Comparative Estimate of Hydropower Generation in IAIR	Comparative estimates of hydropower generation	2 power options	Single power option	Single power option

Notes:
[1] Four surface water storage measures were considered in Plan Formulation Report; enlarge Millerton Lake by raising Friant Dam, construct Temperance Flat RM 274 Reservoir, construct Temperance Flat RM 279 Reservoir, and construct Fine Gold Reservoir.
[2] CVP and SWP water operations integration was only assessed in the Plan Formulation Report (Reclamation 2008a).

Key:
CVP = Central Valley Project
FKC = Friant-Kern Canal
IAIR = Initial Alternatives Information Report (Reclamation 2005b)
N/A = not applicable
RM = river mile
SJR = San Joaquin River
SLIS = selective level intake structure
SWP = State Water Project
TAF = thousand acre-feet
TCD = temperature control device

Initial Evaluation of Operation Assumptions

During this stage, future without-project conditions were updated to represent operations of the CVP and SWP system under the 2008/2009 BOs instead of the 2004/2005 BOs included in the PFR. Under the 2008/2009 BOs the more restrictive Delta export constraints drastically limited the water supply benefits of integration of the Temperance Flat RM 274 reservoir with the overall SWP/CVP systems. Based on the PFR, with minimal carryover storage in Temperance Flat RM 274 Reservoir, the difference in water supply between scenarios that consider integration under the 2004/2005 BOs and scenarios without integration that develop new water supply from the San Joaquin River only is approximately 70 TAF, and would be even greater with increased carryover storage in Temperance Flat RM 274 Reservoir. Because of the limited benefits of integration under the 2008/2009 BOs, CVP and SWP integration opportunities were not considered further in the development of Temperance Flat RM 274 Reservoir alternative plans.

Thirty sets of operation assumptions were investigated in this stage to better understand how they accomplish planning objectives and meet planning criteria. The analysis evaluated implications and trade-offs within the range of each operation assumption. For example, a range of minimum carryover storage target volumes from 100 TAF to 700 TAF were initially evaluated, with active storage fluctuating above the minimum carryover target. Variations in minimum carryover storage targets demonstrated trade-offs between various planning objectives. Water supply reliability and flood damage reduction improved with smaller minimum carryover storage, while hydropower generation, temperature management, emergency water supply, and recreation increased with greater minimum carryover storage.

Based on the results of this analysis, the potential range of operation assumptions was limited to the following:

- Maintain Temperance Flat RM 274 Reservoir minimum carryover storage targets to less than 400 TAF to balance project objectives (water supply and emergency water supply, water temperature, hydropower, recreation).

- Maintain a relatively constant Millerton Lake storage of 340 TAF to balance project objectives (hydropower, recreation, water supply and emergency water supply, water temperature).

- Maintain multiple project beneficiaries to meet project objectives (economic and financial feasibility).

- Include an SLIS to improve reservoir cold-water pool management and release temperatures to the San Joaquin River.

Results from this stage also demonstrated that multiple water supply beneficiaries would likely be necessary for the project to be economically and financially feasible. Scenarios that were tested with a single agricultural beneficiary demonstrated that delivery of all the new water supply to agriculture would not be economically feasible. Further studies did not retain the concept of a single project beneficiary for water supply.

Refinement of Operation Assumptions

Building on insights developed in the previous stage, reservoir operation assumptions were refined and grouped into 10 scenarios, with varying priorities placed on the primary planning objectives. Analyses included varying the volume of new water supply delivered to beneficiaries, and routing new supplies via the Friant-Kern and Madera canals as well as the San Joaquin River and Mendota Pool (to be conveyed to CVP SOD contractors or wildlife refuges or exchanged for delivery to SWP M&I via the California Aqueduct). Consideration was given to Level 2 refuge diversification and providing incremental Level 4 refuge supplies during this stage, but incremental Level 4 deliveries were not included in the alternative plans formulated in subsequent stages of operations development for alternative plans. The scenarios in this stage also included three levels of Temperance Flat RM 274 Reservoir minimum carryover storage targets to better characterize potential water supply reliability and ecosystem benefits.

An SLIS was incorporated in several scenarios to improve river temperatures, with varying operations and timing. During this stage the ecosystem benefits assessment was expanded from inferring salmon habitat improvements from river temperature improvements to explicit modeling of spring-run Chinook salmon habitat improvements due to flow and temperature changes.

Formulation of Alternative Plans

The performance of different sets of operation assumptions determined in the Draft Feasibility and Plan Refinement Phase process were then used to develop four alternative plans or sets of assumptions that would meet planning objectives to varying degrees. Further details regarding formulation of the operations assumptions are included in the following section and the four alternative plans are described in detail along with their potential physical accomplishments in Chapter 4.

Range of Operations Assumptions Included in Alternative Plans

There are a number of operations assumptions and variations in implementing each assumption that affects the performance of the alternatives in meeting planning objectives and criteria. The alternatives formulated through the operations refinement process represent a reasonable range of (1) planning objective achievements and opportunities, (2) reservoir-balancing and water management actions between Millerton Lake and Temperance RM 274 Flat Reservoir, and (3) multitude of new water supply beneficiaries. Features, operations, and assumptions for Temperance Flat RM 274 Reservoir alternative plans and the No-Action Alternative are described in Chapter 4.

This section contains details of operation assumptions in the alternative plans and how they affect project accomplishments. These major operations variables include Millerton Lake/Friant Dam operations, Temperance Flat Reservoir and Dam operations, new water supply beneficiaries, and new water supply routing. Operational rules for management of storage levels between Millerton Lake and Temperance Flat RM 274 Reservoir significantly affect all potential project accomplishments. Water supply reliability and flood damage reduction are influenced by total carryover storage in the two reservoirs; and river release temperature, hydropower management, and recreation are strongly influenced not only by total carryover storage, but by the balancing of storage between the two reservoirs.

Alternatives Focus

Constants – All alternative plans include constructing Temperance Flat RM 274 Dam and Reservoir.

Variables – The alternatives vary based on operations (conveyance routing, potential beneficiaries, and carryover) and intake feature configurations.

Millerton Lake/Friant Dam Operations

Millerton Lake has historically been operated as an annual reservoir with a diversion dam, with annual fluctuations of up to 110 feet between the Friant-Kern Canal outlet near elevation 470 and the top of active storage at elevation 580, depending on timing of inflow and demands. Evaluation of operations studies demonstrated that operations with stable Millerton Lake levels would result in multiple benefits, including cold water pool management, hydropower, and recreation, while only slightly decreasing water supply reliability. The alternative plans in the Draft Feasibility Report consider one Millerton Lake fixed carryover storage target at elevation 550 (340 TAF target storage), which would improve recreation by balancing shoreline and lake use.

Temperance Flat RM 274 Reservoir Operations

Constructing Temperance Flat RM 274 Dam and Reservoir would create a storage capacity of 1,331 TAF, reduce the storage capacity of Millerton Lake by about 75 TAF, and create additional net storage capacity of about 1,260 TAF. The top of active storage in Temperance Flat RM 274 Reservoir would be at elevation 985. A range of minimum carryover storage target volumes from 200 TAF to 325 TAF (elevation 671 to 731) is represented in the alternative plans, to support a minimum pool for cold water management, emergency water supply, recreation, and hydropower energy generation. Water levels in Temperance Flat Reservoir would fluctuate significantly above the minimum carryover target level, depending on the time of year and water year type.

New Water Supply Beneficiaries

Temperance Flat RM 274 Reservoir could influence SOD water management by increasing water supply deliveries through various conveyance options, including the Friant-Kern Canal and the Cross Valley Canal to the Friant Division and SWP contractors and the San Joaquin River to Mendota Pool. Potential beneficiaries of Temperance Flat RM 274 Reservoir new water supply include the Friant Division, CVP SOD agricultural contractors, and SWP SOD M&I contractors. San Joaquin Valley CVP wildlife refuges could also benefit by receiving higher quality San Joaquin River water supplies through Level 2 refuge diversification.

General options for routing water supply to different beneficiaries are shown in Figure 3-5. Delivery of new supplies to the Friant Division considered long-term contract rules, conveyance capacities, delivery patterns, and changes due to the Settlement. The Friant Division would see improved water supply reliability due to shifting Section 215 water to Class 2 supplies. Delivery of new supplies to CVP SOD contractors was limited to current CVP SOD contract allocation limits, and to contractors with access to Mendota Pool, the DMC, or the California Aqueduct. Delivery to SWP M&I contractors was based on the assumption that they would have demand for any amount of water supply delivered from Temperance Flat Reservoir, within conveyance constraints.

New Water Supply Routing

New water supply to the Friant Division would be delivered via the Friant-Kern and Madera canals. Supply to the CVP SOD contractors and to wildlife refuges could be delivered via the San Joaquin River to Mendota Pool for delivery or exchange to contractors with access to Mendota Pool, the DMC, or the California Aqueduct. SWP M&I water supply could be directly delivered via the Friant-Kern Canal, cross-valley conveyance, and the California Aqueduct. SWP M&I supply could also be delivered via the San Joaquin River and Mendota Pool, exchanged with Level 2 refuge supply or exchange with CVP SOD deliveries, and then via the California Aqueduct. Direct delivery of Temperance Flat RM 274 Reservoir water supply to SWP M&I contractors may require modifications to the place of use for the CVP. Alternatively, Temperance Flat RM 274 Reservoir could be developed as a joint CVP and SWP facility, or the SWP may be added as a CVP contractor to have access to Temperance Flat Reservoir water supply, which would also require institutional changes.

Cross Valley Canal/Friant-Kern Canal Intertie

This intertie could be used to deliver or exchange new water supplies.

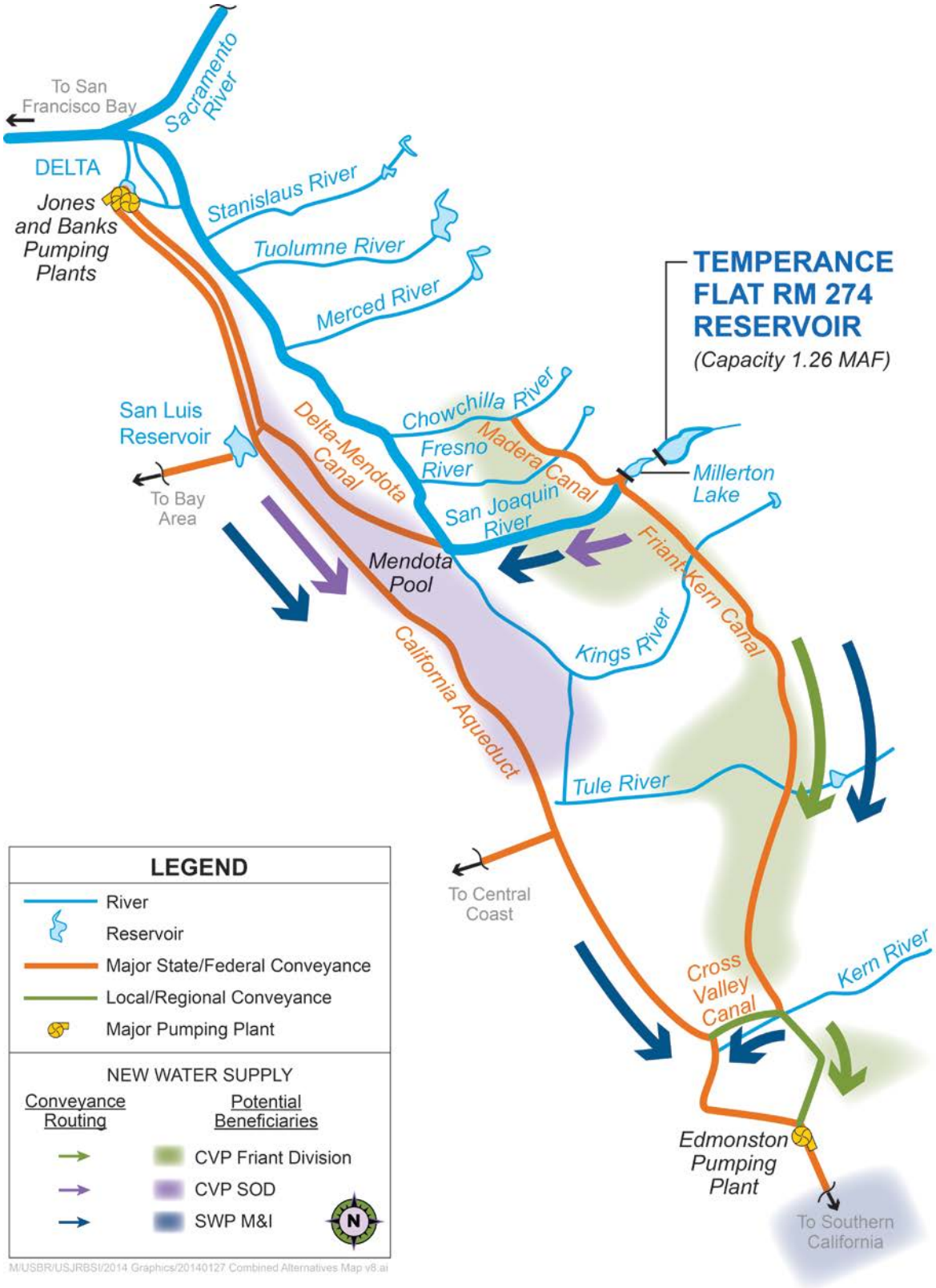

Figure 3-5. Potential Temperance Flat Reservoir Water Supply Beneficiaries and Routing Options

Sensitivities for Operation Assumptions

The process of refining operations assumptions for alternative plans illustrates trade-offs between accomplishments tied to active storage capacity (long-term average water supply reliability and flood damage reduction) and those tied to a minimum carryover storage target (cold water pool, emergency water supply, hydropower generation, and recreation). In addition to the relative balancing of active and carryover storage, the water supply reliability accomplishments of Temperance Flat RM 274 Reservoir are also sensitive to CVP and SWP operating conditions in the Delta, and potential new conveyance in the Delta and between the east side and west side of the San Joaquin Valley.

The SJRRP has an effect on the formulation of alternative plans and is included in the future without-project conditions and No Action Alternative for the Investigation. The Temperance Flat RM 274 Reservoir alternative plans would also affect the Restoration and Water Management goals of the Settlement being implemented through the SJRRP.

This section summarizes the sensitivity of water supply reliability accomplishments of the alternative plans to carryover storage, CVP and SWP operating conditions and conveyance, and the potential effects of the alternative plans on the SJRRP.

Carryover Storage

The alternative plans were formulated to balance traditional water supply reliability accomplishments (dependent on active storage capacity) with accomplishments tied to ecosystem and other public benefits (many of which are influenced by minimum carryover storage). This approach also is intended to maximize net benefits consistent with the P&G, maximize potential public benefits consistent with SBX7-2, and incorporate the various planning objectives for the Investigation.

Long-term average water supply reliability increases with greater active storage and smaller volumes of minimum carryover storage, which would capture more San Joaquin River flood flows for delivery. Table 3-7 summarizes analyses performed to illustrate the sensitivity of Temperance Flat RM 274 Reservoir new water supply to changes in minimum carryover storage.

Table 3-7. Long-Term Average Annual Change in Deliveries for Temperance Flat RM 274 Reservoir with Varying Minimum Carryover Storage Target

Minimum Carryover Storage in Millerton Lake and Temperance Flat Reservoir (TAF)[1]	230	320	440	540	665
Active Storage Capacity in Millerton Lake and Temperance Flat Reservoir (TAF)[2]	1,550	1,460	1,340	1,240	1,115
Average Annual Change in Deliveries (TAF)[3,4,5]	98	91	85	70 – 76[6]	61[7]

Notes:
[1] Combined total storage capacity = 520 TAF Millerton + 1,260 TAF Temperance Flat = 1,780 TAF.
[2] Active storage capacity = total storage capacity minus minimum carryover storage.
[3] Alternative Plans compared to No-Action Alternative.
[4] All estimates of new water supply/change in deliveries based on CVP and SWP operating conditions with the 2008/2009 BOs.
[5] The values represent the net change in CVP/SWP system-wide deliveries, accounting for new deliveries from Temperance Flat and decreases in Delta exports due to the decrease in San Joaquin River flood flows. These sensitivity scenarios are based on storage of San Joaquin River supplies only and do not include operations integration with the broader CVP and SWP.
[6] Values represent the range of new water supply for Alternative plans 1, 2, and 3, which include the same minimum carryover.
[7] Value for new water supply represents Alternative Plan 4.
Key:
BO = Biological Opinion
CVP = Central Valley Project
RM = River Mile
SWP = State Water Project
TAF = thousand acre-feet

For ecosystem improvements, greater active storage correlates to more new water supply and therefore more potential flow-related improvements, while greater carryover storage can support more temperature-related improvements. San Joaquin River ecosystem enhancement for anadromous fish is also related to water supply routing when using the river as a conveyance route to Mendota Pool.

CVP and SWP Operating Conditions and Conveyance

The magnitude of new water supply that could be developed by Temperance Flat RM 274 Reservoir is strongly influenced by CVP and SWP operating conditions and conveyance. Analysis of Temperance Flat RM 274 Reservoir in the draft feasibility phase with operating conditions under the 2008/2009 BOs focuses on developing new water supply by storing wet year water supplies from the San Joaquin River that would otherwise be released from Friant Dam as flood flows.

Operations of Temperance Flat RM 274 Reservoir could also be integrated with the broader CVP and SWP SOD export and storage system, as evaluated in the PFR, to provide additional water supply reliability by capturing additional Delta water supply in wet years through exchange. This operation was not included in the draft feasibility phase since operating conditions under the 2008/2009 BOs result in San Luis

Reservoir filling less frequently, which makes integration less feasible. Assumptions regarding CVP and SWP operating conditions in the Delta do not affect the modeled new water supply generated from capturing San Joaquin River flood flows, but do affect changes in Delta exports the ability to develop additional wet year water supply from the Delta through exchange.

Evaluation of operations integration with the CVP and SWP system under future conditions with increased flexibility for CVP and SWP Delta export operations would likely result in significantly greater estimates of water supply reliability from Temperance Flat RM 274 Reservoir. Potential new Delta conveyance would increase the frequency of San Luis Reservoir filling and, correspondingly, increase the use of the available storage space in Temperance Flat RM 274 Reservoir for exchanges. This integrated operation of San Luis Reservoir with Temperance Flat RM 274 Reservoir could improve the ability to manage water supply for multiple purposes.

Increasing "transvalley" conveyance capacity (between the east side and west side of the San Joaquin Valley) through construction of a new major transvalley canal would further enable potential integration between Temperance Flat RM 274 Reservoir and the SWP and/or CVP system outside the Friant Division through water exchanges. A conceptual alignment for the canal could include up to a 1,000 cfs bi-directional connection between the Friant-Kern Canal near Porterville and the California Aqueduct south of the Tulare Lake bed (Reclamation 2008).

Some previous studies of potential Temperance Flat RM 274 Reservoir operations represented conditions with the 2004/2005 BOs, operations integration with the broader CVP and SWP system, and potential changes in transvalley and/or Delta conveyance. These studies, summarized in Table 3-8, illustrate the sensitivity of the new water supply that could be developed to changes in CVP and SWP operating conditions and conveyance.

Integration with CVP and SWP

Integrating operations with the CVP and SWP would include coordinated management of water supplies in Millerton Lake and Temperance Flat RM 274 Reservoir with operations of SWP and other CVP facilities.

- This could involve delivery of water supplies to the Friant Division in combination with water exchanges between the Friant Division and SWP and other CVP service areas. Some SWP or CVP water supplies from the Delta that are diverted to San Luis Reservoir could instead be delivered to water users in the Friant Division, while San Joaquin River water could be stored in the new Temperance Flat RM 274 Reservoir.
- This would provide additional available storage capacity in San Luis Reservoir during wet periods, which could allow capture of additional supplies from the Delta. Accumulated San Joaquin River water supplies would be provided through exchange to SWP and CVP SOD water users when available Delta supplies are less than demand.

With operations integration, Temperance Flat RM 274 Reservoir would not only be operated as an enlargement of Millerton Lake for managing flood or high flows on the San Joaquin River (functioning as a reservoir upstream from the Delta), but also operated as an expansion of SOD offstream storage (like a San Luis Reservoir on the east side of the San Joaquin Valley) to capture additional Delta supplies through exchange (functioning as a reservoir downstream from the Delta).

Source: DWR 2010b

Table 3-8. Long-Term Average Annual Change in Deliveries for Temperance Flat RM 274 Reservoir with Varying CVP/SWP Operations and Conveyance

Row ID	CVP and SWP Operations (BOs)	Total Minimum Storage in Millerton and Temperance Flat (TAF)[1]	Integration with CVP and SWP	New Delta Conveyance[2]	New Transvalley Conveyance[3]	Average Annual Change in Deliveries (TAF)[4]
A	2008/2009	230	--	--	--	98[5]
B[6]	2004/2005	230	--	--	--	113[5]
C[6]	2004/2005	230	☑	--	--	158 – 180[7]
D[6]	2004/2005	230	☑	--	☑	240
E[8]	2008/2009	230	☑	--	--	140
F[8]	2008/2009	230	☑	☑		230

Notes: General: Draft Feasibility Report alternative plans assume 2008/2009 BOs with No Integration, No New Delta Conveyance, and No New Transvalley Conveyance, with a total minimum carryover in Temperance Flat and Millerton of 540 to 665 TAF.

[1] Minimum storage in Millerton Lake is 130 TAF; minimum storage in Temperance Flat is 100 TAF.

[2] Assumed capacity and configuration of new Delta conveyance representation not specified in DWR 2010b.

[3] Assumed new 1,000 cfs bi-directional Transvalley canal connecting Friant-Kern Canal and California Aqueduct. Water supply delivery estimate would be smaller with 2008/2009 BOs.

[4] Alternative Plans compared to No-Action Alternative. Values represent the net change in CVP/SWP system-wide deliveries, accounting for new deliveries from Temperance Flat Reservoir and decreases in Delta exports due to the decrease in San Joaquin River flood flows. All scenarios presented assume implementation of the SJRRP.

[5] The 2 scenarios without integration would result in the same water supply developed from Temperance Flat and the same reduction in San Joaquin River flood flows, but the values with 2008/2009 BOs are smaller than with 2005/2005 BOs due to additional reductions in Delta exports.

[6] Source: Reclamation 2008a

[7] A range of values is presented since multiple scenarios were evaluated

[8] Source: DWR 2010b

Key:
BO = Biological Opinion
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
DWR = California Department of Water Resources
RM = River Mile
SWP = State Water Project
TAF = thousand acre-feet
Reclamation = Bureau of Reclamation

Compared to the 113 TAF long-term average new water supply that could be developed by Temperance Flat RM 274 Reservoir with minimal carryover storage and no integration with the 2004/2005 BOs (row B), Table 3-8 illustrates that water supply accomplishments would increase with additional flexibility for CVP and SWP Delta export operations (whether through regulatory changes or new Delta conveyance) and with increased transvalley conveyance capacity, as follows:

- Up to 59 percent (67 TAF) increase in water supply with integration under 2004/2005 BOs (row C).
- Up to 112 percent (127 TAF) increase in water supply with integration under 2004/2005 BOs and new transvalley conveyance (row D).

- Up to 24 percent (27 TAF) increase in water supply with integration under 2008/2009 BOs (row E).

- Up to 104 percent (117 TAF) increase in water supply with integration under 2008/2009 BOs and new Delta conveyance (row F).

San Joaquin River Restoration Program

The construction and operation of Temperance Flat RM 274 Reservoir would not interfere with implementation of the SJRRP, but would change water management at Friant Dam and affect the Restoration and Water Management goals of the Settlement being implemented through the SJRRP. Storing water in Temperance Flat Reservoir would reduce the frequency and magnitude of flood flows that would occur in excess of water rights, Restoration Flow releases, and water deliveries. The additional stored water would be managed for several purposes, including facilitating controlled releases of Restoration Flows that otherwise would have been flood flows that would have contributed to or met Restoration Flow targets. It would also capture and store flows that otherwise would have been delivered to the Friant Division Contractors at $10 per acre-foot to reduce the Recovered Water Account (RWA) or released from Friant Dam as flood flows to the San Joaquin River.

Restoration Goal Potential Effects

- Construction and operation of Temperance Flat Reservoir would not interfere with the release of Restoration Flows specified in the Settlement. All Restoration Flow provisions, including flows consistent with the Exhibit B hydrographs, buffer flows, pulse flows, riparian establishment flows, flow ramping, and the management of releases during flexible flow periods, would continue to be implemented as required by the Settlement.

- The increased volume of water stored in Millerton Lake and Temperance Flat Reservoir would increase the volume of cold water and improve operational flexibility in the management of Restoration Flows, and would provide additional flow from Friant Dam to Mendota Pool (for water supply exchanges).

- With Temperance Flat Reservoir, the reduced frequency and magnitude of flood flows in the San Joaquin River would have the following effects on implementation of the Settlement:
  - Losses of gravel from Reach 1 of the San Joaquin River that would occur during high flood flows would be reduced, thereby reducing maintenance costs for gravel replenishment requirements.
  - Sediment accumulation downstream from Reach 1 due to sand mobilization would be reduced, thereby reducing operation and maintenance costs by the SJRRP to preserve the function of the San Joaquin River Flood Control Project.
  - Connectivity with gravel pits in Reach 1 that causes stranding of salmon and other fish would occur less frequently and for shorter duration, thereby potentially reducing the extent of gravel pit isolation that would be implemented as a Phase 2 action of the Settlement.
  - Reduction/elimination of late season flood flows could reduce potential to damage newly established riparian habitat.
  - Reduction of spring flood flows could reduce floodplain rearing habitat for salmonids within Reaches 1 and 2.
- The overall net effects of the alternative plans on the Restoration Goal and San Joaquin River ecosystem would be positive; however, the beneficial effects of the alternative plans from providing improved cold water pool/water temperatures and additional flow could be slightly offset by a reduction in floodplain rearing habitat for salmonids in Reaches 1 and 2.

Water Management Goal Potential Effects

- The capture and storage of flood flows in Temperance Flat Reservoir, beyond those that would have been delivered as $10 water under Paragraph 16(b) of the Settlement, and the subsequent release of portions of the stored water as Restoration Flows would not increase water supply impacts to Friant Division long-term contractors.

- Release of stored flood flows as managed Restoration Flows would increase the volume of Restoration Flows eligible for recapture at locations downstream from the Restoration Area, pursuant to Paragraph 16(a) of the Settlement.

- Using Millerton Lake as a forebay of Temperance Flat Reservoir would reduce or eliminate the exposure of the Friant-Kern Canal and Madera Canal intakes due to releases of Restoration Flows.

- Capture and storage of flows in Temperance Flat Reservoir would reduce the availability of $10 water under Paragraph 16(b) of the Settlement and could reduce the effectiveness of projects that would increase the delivery of Paragraph 16(b) water.

- The Friant Division contractors would be affected by the increase in cost to deliver stored Temperance Flat Reservoir water that would have otherwise been released as $10 water, but with Temperance Flat Reservoir could receive a greater volume of water supply and greater water supply reliability. In addition, the Friant Division contractors would be affected if the volume of water made available from Temperance Flat Reservoir is not made available to them and is stored for other CVP contractors. This would reduce the SJRRP's ability to reduce RWA balances.

Climate Change

All alternative plans, including the No-Action alternative, are projected to be impacted by climate change this century. Sea level rise would impact salinity in the Delta and operations of the CVP and SWP. Hydrological changes would impact the timing and availability of inflows into Temperance Flat RM 274 Reservoir and Millerton Lake. For the Investigation, hydrological impacts of climate change on the No-Action Alternative and an alternative plan were evaluated for projected climate conditions in the year 2060. CalSim II was used to evaluate how an example alternative plan could support the water supply reliability planning objective under projected 2060 sea level and hydrology. By 2060, sea level is projected to rise by an average of 45 cm using empirical models developed by Ramsdorf (2007). The hydrology developed to evaluate the No-Action and an example alternative plan for the preliminary climate change sensitivity analysis represents the central estimate of future climate change for the 30-year climatological periods centered on the analysis year 2060. This preliminary analysis is discussed in further detail in the Modeling Appendix Attachment C.

For the No-Action Alternative, modeling considering climate change estimated that Friant Division Class 1 supplies could decrease by as much as 10 percent on an annual basis, with more severe impacts in dry and critical years. Temperance Flat RM 274 Reservoir could provide the capacity to adapt to changing inflow timing, with the result that less water would be spilled as flood flows, and more could be delivered as water supply, providing long-term average annual as well as dry and critical year benefits. For an example alternative plan, Friant Division Class 1 supplies were simulated to decrease by less than 1 percent on an annual basis in all year types when considering climate change, compared to the conditions with an example alternative plan without using climate change hydrology.

Climate change analyses performed for this report are preliminary and will be revised and expanded for the Draft EIS/EIR and Final Feasibility Report.